METHOD AND APPARATUS FOR PROVIDING MULTI-POINT HAPTIC FEEDBACK TEXTURE SYSTEMS

RELATED APPLICATIONS

[0001] This application is related to the following co-pending applications, each assigned to the Assignee of the present invention.

[0002] a. application Ser. No. 11/823,192, filed Jun. 26, 2007, Attorney Docket No. IMM255 (1057.P0002US), entitled "Method and Apparatus for Multi-touch Tactile Touch Panel Actuator Mechanisms";

[0003] b. application Ser. No. 11/823,258, filed Jun. 26, 2007, Attorney Docket No. IMM272 (1057.P0003US), entitled "Method and Apparatus for Multi-touch Haptic Touch Panel Actuator Mechanisms"; and

[0004] c. application Ser. No. 11/943,862, filed Nov. 21, 2007, Attorney Docket No. IMM290 (1057.P0014US), entitled "Method and Apparatus for Providing a Fixed Relief Touch Screen with Locating Features Using Deformable Haptic Surfaces."

FIELD

[0005] The exemplary embodiment(s) of the present invention relates to a field of electronic interface devices. More specifically, the exemplary embodiment(s) of the present invention relates to an interface device with haptic feedback.

BACKGROUND

[0006] As computer-based systems, appliances, automated teller machines, point of sale terminals and the like have become more prevalent in recent years, the ease of use of the human-machine interface has become increasingly important. A conventional touch-sensitive panel usually has a smooth flat surface and uses sensors such as capacitive sensors and/or pressure sensors to sense locations being touched by a finger(s) and/or an object(s). For example, a user presses a region of a touch screen commonly with a fingertip to emulate a button press and/or moves his or her finger on the panel according to the graphics displayed behind the panel on the display device.

[0007] In the real world, there exists a wide variety of surface textures. Textures are used to describe visual structures as well as feel of touching to various surfaces. For a human-computer interface device, a user is often presented with virtual textures in the form of images displayed on computer screens. For example, images of sandpaper and/or corduroy may be seen, but the user typically can not feel what the sandpaper or corduroy feels like when he or she touches the display or touch screen. If a touch screen or surface is used, the texture of that screen may be felt as a typical smooth surface, which usually does not simulate texture(s) of what those on-screen images are displaying. Even if the touch screen or touch surface is coated with an artificial texture such as a raised surface, the user is only able to feel a single coated texture.

[0008] A problem associated with the conventional touch-sensitive panel is that it does not provide configurable texture information to a user. Another problem associated with the conventional touch-sensitive panel is the inability to provide input confirmation when a user enters an input outside of visual cues, or audible cues when coupled with a sound system. For example, when a user presses a location on a conventional touch-sensitive panel, the panel typically does not have the capability to confirm the selected input instantaneously as would a mechanical switch.

SUMMARY

[0009] A method and surface reconfigurable haptic device capable of providing a haptic texture using a deformable surface are disclosed. The surface reconfigurable haptic device includes a flexible surface, a haptic substrate, and a deforming mechanism. The flexible surface is a soft and elastic layer, which is capable of changing its surface characteristics from one texture to another texture. The haptic substrate, in one embodiment, provides a first pattern in response to a first activating signal. Alternatively, the haptic substrate provides a second pattern in accordance with a second activating signal. The deforming mechanism is configured to change the flexible surface from a first surface characteristic to a second surface characteristic in accordance with the first pattern.

[0010] Additional features and benefits of the exemplary embodiment(s) of the present invention will become apparent from the detailed description, figures and claims set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The exemplary embodiment(s) of the present invention will be understood more fully from the detailed description given below and from the accompanying drawings of various embodiments of the invention, which, however, should not be taken to limit the invention to the specific embodiments, but are for explanation and understanding only.

[0012] FIGS. **1**(*a-e*) illustrate haptic devices using haptic substrates and flexible surfaces in accordance with one embodiment of the present invention;

[0013] FIGS. **2**(*a-d*) illustrate cross-section diagrams illustrating a haptic device having a deformable surface in accordance with one embodiment of the present invention;

[0014] FIGS. **3**(*a-f*) illustrate cross-section diagrams illustrating alternative examples of a haptic device using a deformable surface in accordance with one embodiment of the present invention;

[0015] FIGS. **4**(*a-d*) illustrate examples of haptic cells in a haptic device employing piezoelectric materials and Micro-Electro-Mechanical Systems ("MEMS") elements in accordance with one embodiment of the present invention;

[0016] FIG. **5**(*a-b*) illustrates a side view of a haptic device having an array of haptic cells with thermal fluid pockets in accordance with one embodiment of the present invention;

[0017] FIG. **6**(*a-b*) illustrates a haptic cell employing Micro-Electro-Mechanical Systems pumps to generate haptic effects in accordance with one embodiment of the present invention;

[0018] FIG. **7** illustrates a side view diagram for a haptic device having an array of haptic cells using variable porosity membrane in accordance with one embodiment of the present invention;

[0019] FIG. **8** is a side view of a haptic device having an array of haptic cells using various resonant devices in accordance with one embodiment of the present invention; and